

## DISTRIBUTION OF WARNINGS OF SEVERE STORMS

*General distribution.*—Hurricane and other warnings of severe storms are telegraphed or cabled from the Central Office of the Weather Bureau in Washington direct to officials in charge of principal and substations of the Bureau in the districts affected; also to the radio broadcast stations at Brownsville, Tex., New Orleans, La., and Key West, Fla., for radio broadcast at those points.

The Navy Department (Communications Office for Arlington) also receives a copy of warnings of all severe storms. The weather bulletin broadcast daily by the Arlington station (NAA) includes in addition to the weather data warnings of severe storms as issued by the Weather Bureau.

Press associations are also supplied with telegraphic advices of storm warnings.

Advices of the coming of the hurricane, in the present case, were perhaps as widely, if not more widely distributed than ever before due to the multiplication of radio broadcasting stations. The radio service at New Orleans, in particular, was especially effective, one station broadcasting hourly bulletins.

Space does not permit mention of the valuable services of individuals and organizations in spreading the warnings and the subsequent advices as issued.

Below is given copies of the more important warnings issued; the arrangement is chronological.

*September 15, 10:02 a. m.*—Tropical disturbance reported northeast of St. Kitts Tuesday morning has moved directly westward. Now centered short distance north St. Thomas, Virgin Islands. This storm has already attained considerable intensity.

*September 16, 3 p. m.*—Center of hurricane of great intensity passing near Turks Island which reports wind one hundred miles from northwest. Hurricane center will pass near or slightly north of Crooked Island, Bahama group, Friday forenoon. Greatest caution advised vessels bound for Bahama group and adjacent waters.

*September 16, 9:30 p. m.*—Third tropical storm has passed Turks Island moving west-northwestward attended by dangerous shifting gales. Caution advised vessels bound for Florida Straits, Bahamas and adjacent waters.

*September 17, 10:20 a. m.*—Hoist northeast storm warning twelve noon Jupiter Inlet to Key West. Hurricane central about twenty-three north seventy-four west moving west-northwestward attended by winds hurricane force near center. This is a very severe storm. Its center will likely pass near Nassau early to-night. Great caution advised all vessels bound Florida Straits, Bahama Islands, and east Florida coast. Every precaution should be taken for destructive winds Saturday morning especially Jupiter to Miami.

To the Governor General, Nassau, Bahamas, the following message was sent:

*September 17, 10:02 a. m.*—Please send special observations every two hours to-day. Hurricane central near and north Crooked Island and its center will likely pass near Nassau early to-night. This is a destructive storm.

## AN INTERPRETATION OF THE WIND VELOCITY RECORD AT MIAMI BEACH, FLA., SEPTEMBER 17-18, 1926

551.55 (759)

By BENJAMIN C. KADEL, in charge of Instrument Division

[U. S. Weather Bureau, Washington, D. C.]

Dr. Scott R. Edwards, superintendent of Allison Hospital, Miami Beach, Fla., has kindly furnished to the Weather Bureau, through R. W. Gray of the Miami office of the Weather Bureau, a record of the wind movement at Miami Beach about 4 miles east of the city of Miami during the hurricane of September 17 and 18, 1926. The hospital is three-fourths of a mile north of the northern limit of the center of the hurricane. The anemometer, a 3-cup Robinson anemometer, cups 5 inches in diameter on arms 6.29 inches long, factor 2.50,

*September 18, 1:30 p. m.*—Hoist northeast storm warning 4 p. m. north of Jacksonville to Charleston and west of Mobile to mouth of Mississippi River. Hurricane center noon over extreme southern Florida, Fort Myers reporting barometer 29.04, wind fifty-two miles north. Hurricane will pass into Gulf of Mexico this afternoon and continue to move west-northwestward for the present. This is a very severe storm. Greatest caution advised vessels in its path.

*September 18, 9:45 p. m.*—Change to hurricane warning 11 p. m. Apalachicola, Fla., to Burrwood, La. Hurricane central between twenty-six and twenty-seven north and about eighty-three west moving west-northwestward attended by winds of hurricane force. This is a very severe storm. Unless course changes hurricane center will move inland, most likely between Pensacola and mouth of Mississippi River Sunday night. Emergency. Every precaution should be taken against destructive winds.

*September 19, 10 a. m.*—Advisory 10 a. m. Hurricane apparently central between twenty-seven and twenty-eight north and about eighty-five west moving west-northwestward attended by dangerous shifting gales. Unless course changes hurricane center will move inland late to-night between Pensacola and mouth of Mississippi River, probably nearer the latter. Further advices this afternoon. Meanwhile every precaution should be taken against destructive east and northeast winds beginning to-night all points where hurricane warnings are displayed.

*September 19, 2:30 p. m.*—At 2:30 p. m. of the 19th the following advisory warning was sent to all stations from Apalachicola to Burrwood, inclusive, and hurricane warnings were ordered continued at 11 p. m. at all display stations within this area:

Noon specials indicate hurricane center near twenty-eight north eighty-six west moving west-northwestward. This is a hurricane of great intensity and magnitude and emphasis should be placed on need of every possible preparation for destructive winds, especially Pensacola to mouth of Mississippi River. Hurricane center will likely pass inland late to-night or Monday morning.

Then the final advisory before the hurricane center approached the coast was as follows:

*September 19, 9:30 p. m.*—Advisory 9:30 p. m. Hurricane central about twenty-nine north eighty-seven west apparently moving northwestward. Hurricane center will pass inland early Monday morning, probably not far from the Pensacola-Mobile section.

*The local distribution.*—Each local Weather Bureau station in the storm area distributes the warnings by telephone directly to all persons and organizations that have vital interests to be served. In urgent cases such other means of quick personal distribution as are available are utilized. In the present case the Tampa official enlisted the services of the local Boy Scout organization. Other officials took advantage of such means as were at hand, but in the main chief reliance is placed on the telephone, the radio, and the daily local press.

Special acknowledgement is made to the *Mobile Register* for issuing a special edition on Sunday, September 19, giving the latest information respecting the hurricane. Space does not permit a recital of the details of the local distribution at the various Weather Bureau stations in the storm-stricken area; suffice it to say that each and every employee was faithful to the trust imposed in him, and made the widest distribution humanly possible.

was exposed 19 feet above the roof and 40 feet above the ground, the ground being 5 feet above mean sea level. It was on the eastern or ocean side of the hospital roof, about 1,200 feet from the ocean, and freely exposed to wind from all directions. The anemometer was equipped to close an electrical circuit for each mile of travel of the wind, the 9th and 10th miles being connected together to aid in identification of the record.

The record was made on a standard Weather Bureau pattern meteorograph, variously called triple register or

quadruple register, which is a simple chronographic recorder having a chart speed of  $2\frac{1}{2}$  inches per hour. A record sheet that had been used for testing was employed, and while the sheet was not placed on the instrument in exactly the customary manner, the time has been indicated in pencil notation by Dr. F. J. Payton of the hospital staff. Careful examination of the record shows smooth uniform motion of the cylinder throughout the period, except for two slight jogs in the line during the last three-fourths hour, which indicate some slight readjustment. With these two unimportant exceptions the record is entirely automatic. The instruments were recently purchased from Julien P. Friez and Sons, who regularly manufacture such equipment for the Weather Bureau, and who are familiar with all the requirements. There is every reason for full and complete confidence in the record.

The record shows that the wind increased gradually from 29 miles per hour at 9 p. m. of the 17th, reaching 100 by 4.30 a. m. of the 18th, and continuing above 100 to a peak of 114 at 6:10 a. m., after which there was a slight decrease to a minimum rate of 78 at 6:25 a. m.; this comparatively low rate lasted but 5 minutes, the wind increasing again to above 100 and reaching a 5-minute maximum of 128 by 7:30 a. m., after which the rate continued above 120 until the anemometer blew away at 8:12 a. m.

The rates above given are for periods of 5 minutes, and are subject to the following small instrumental corrections: At 40, -2; at 60, -3; at 80, -4; at 100, -5; at 120, -5; at 130, -5; at 140, -6. There are several instances on the record of higher rates maintained for two adjacent miles, the highest being 138 at 7:40 a. m. A still higher rate for one mile at 7:43 a. m. has been discarded because the longer mile just preceding it indicates possible disturbance of the record cylinder. It has been customary for many years to use 5-minute velocities in Weather Bureau records and publications because of recognized difficulty in interpretation due to irregular movement of the cylinder, inequalities in length of contacts, and particularly the inertia of the cup wheel in gusty wind. For comparisons with other 5-minute records it is desired to state that the 5-minute maximum of 128 means a true velocity of 123 after applying the correction for this form of anemometer determined in the wind tunnels of the Bureau of Standards (1). If this wind had been measured by the well-known 4-cup anemometer, the indicated record would have shown 163 as the 5-minute maximum and 183 as the extreme.

The indicated extreme velocity of 138, maintained for two miles at 7.40 a. m., corrected for known anemometer error, becomes 132 miles per hour. Using Eiffel's value, .0033 SV<sup>2</sup> equals pounds per square foot, we find that the corresponding pressure is 57 pounds per square foot on a flat surface normal to the wind. Individual gusts no doubt exceed the average of two miles. The writer has examined some records from a Dine's pressure-tube anemometer in Washington which show that at extreme (one-mile) velocities between 40 and 50 the gusts were 30 per cent higher, but whether so great an increase occurred in the hurricane is unknown. If gusts exceeding by more than 30 per cent the record of the integrated miles had prevailed, we should expect less uniformity in the time for recording the single miles than the record shows. Few single miles differ greatly in length from adjacent miles.

The following table gives in miles for each hour the total movement, the maximum velocity for 5 minutes,

and the extreme velocity, as indicated on the face of the record, and also the corrected values. The explanation of the use of 2 miles for the extreme at high velocities is found in the difficulty of measuring the record of a single mile.

Hour ending at	Total movement	Recorded		Corrected to true velocity	
		Maximum, 5-minute	Extreme	Maximum, 5-minute	Extreme
10 p. m. ....	31	36	138	35	137
11 p. m. ....	36	41	142	40	141
12 mid. ....	40	46	152	44	150
1 a. m. ....	44	48	152	46	150
2 a. m. ....	51	59	160	57	158
3 a. m. ....	59	65	169	62	166
4 a. m. ....	77	88	104	84	100
5 a. m. ....	97	108	116	104	112
6 a. m. ....	104	108	122	104	117
7 a. m. ....	100	114	124	109	119
8 a. m. ....	114	128	138	123	132
8 to 8.12 a. m. ....	25	124	136	119	130

<sup>1</sup> Extreme from one mile of wind movement.

<sup>2</sup> Extreme from two adjacent miles.

No automatic record of wind direction was made, but the correspondence states that the direction at time of maximum was either east or southeast.

It seems appropriate to refer here to other records of high winds in the United States. The highest known, 186 miles per hour, was measured with a Robinson 4-cup anemometer on Mount Washington, N. H., at 4 a. m., January 11, 1878 (2). The possible error of the anemometer was even then recognized and mentioned in the published account. We now know that this value represents 140 miles true velocity. Some remarks of the observer on duty are as follows: "10th, 11.22 p. m.; east, 112 miles, heavy sleet (window stove in and storm shutters put up); 11.40 p. m., east, 144 miles, light snow; 12 midnight, east, 144 miles, heavy snow; 11th, 1 a. m., east, 150 miles, heavy snow (the roar of the wind is deafening and the building rocks and trembles); 2 a. m., east, 159 miles, heavy snow (another window stove in); 3 a. m., east, 168 miles, heavy snow; 4 a. m., northeast, 186 miles, heavy snow." The record does not state how long the anemometer was exposed between dial readings, but it is not likely to have been more than 5 minutes (the rule in vogue as shown by other journal entries) and may have been but one minute. There was no automatic record.

The Mount Washington record was made in connection with a storm that moved from Cape Hatteras up the Atlantic Coast, characterized as one of the severest ever known along the coast. "Innumerable wrecks occurred, notwithstanding every precaution had been taken."

At Cape Lookout, N. C., on August 18, 1879, a velocity of 138 was recorded, which corresponds to 105 miles per hour true velocity. Following the collapse of the anemometer the observer estimated the maximum at 165, which corresponds to 125 true velocity (3).

At Mobile, Ala., on October 18, 1916, an indicated 5-minute velocity of 115 was recorded, corresponding to a true velocity of 88 (4).

At Pensacola, Fla., on October 18, 1916, a 5-minute maximum of 114, true velocity 87, was recorded. Following the destruction of the anemometer, the estimated maximum was 120, true value 91 (4).

At North Head, Wash., on January 29, 1921, a maximum of 126, true value 96, was recorded. The fastest for one minute was 150, true value 114. Trees were

broken off where their diameter was as much as 4 feet. From examination of the age of trees destroyed, the observer concluded that this was the most destructive storm within 200 years (5).

The Miami Beach record therefore stands as the highest recorded by automatic instruments in the United States.

Engineers and others seeking to apply these velocities to structural problems will find information concerning the average pressure tending to overturn a model in Scientific Paper of the Bureau of Standards No. 523 (6).

#### LITERATURE CITED

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- (3) 1879. Monthly Weather Review, August, p. 5.
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- (5) DAY, P. C.  
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### DESTRUCTIVE GUST AT JUPITER, FLA., FOLLOWING THE MIAMI HURRICANE

By H. B. BOYER, Meteorologist, In charge

[Weather Bureau office, Key West, Fla., October 4, 1926]

Attention is called to a freakish gust of wind of hurricane force that was experienced at Jupiter, Fla., on September 18, during the tropical storm of that date. This gust practically demolished the naval radio station at that place.

The gust that caused so much damage to the Jupiter radio station was unique in that its destructive force was confined to a narrow and well-defined path running from south-southeast to north-northwest with a width of about 400 feet.

A remarkable feature of this gust was that it occurred during a recrudescence of the storm and after the center

had crossed the Florida Peninsula and was well off the west Florida coast.

Blowing with hurricane force from the northeast and east throughout most of Friday night, the wind veered to southeast and south on Saturday, gradually diminishing in velocity to a whole gale. This was in the natural order of events in a tropical storm whose center was moving on a westerly track to the southward of a given point. In all tropical hurricanes, within the area of hurricane winds, the most destructive are those that occur after the center has passed the gusts being of greatest violence and force, but diminishing in frequency and strength as the center recedes. At Jupiter there was a renewal of the storm to hurricane force during Saturday afternoon, the terrific gust that put the radio station out of commission occurring between 8 and 9 p. m.

\* \* \* In the area of great destruction one anchor of the 200-foot north tower containing 12 cubic feet of concrete was completely pulled out of the ground. Part of the roof of the dormitory was blown southward and deposited on the pier. This, in all probability, was done by an eddy, as there was no other evidence that the gust partook of the nature of a tornado.

E. C. Seibert, public works officer, communicates the following:

It appears as though the majority of the damage at Jupiter was done in a very short space of time, 20 or 30 seconds, or even less. Shortly after 8 p. m., September 18th, a very sudden and marked increase in the wind velocity was noted by the personnel, and before the operator in the operating building could get out, the roof was off and the towers were down. No one witnessed the actual falling of the towers. From the manner in which brush and trees were knocked down, and from its effect on various structures, it appears that this sudden volume of wind was very narrow in width, perhaps only about 400 feet. It seems to have run just a few degrees west of north, wrecking the boathouse and carrying away the operating house roof, north and northeast towers, garage, etc. An old empty wooden tank on a comparatively light steel tower on the lighthouse reservation (to the east) was uninjured, although the tank, it is understood, is not fastened down to the top of the tower except by the effect of the riser pipe from the pump. This tank is only about 500 feet east of the operating building. In other words, the eastern extremity of this cyclonic gust seems to have been about 250 feet east of the operating house, while its western boundary was probably 150 feet. Also, the quarters on top the hill, to the east, and known as the old Weather Bureau House, was not materially damaged.

### THE HURRICANE AT TURKS ISLAND, SEPTEMBER 16, 1926

By GEORGE GOODWIN

[Turks Island, West Indies]

At the 8 a. m. readings the weather had taken a very unfavorable change—barometer tending to fall and wind increasing and dropping every few minutes.

On receipt of advice from the bureau that the storm would pass over or near Turks Island, every available means was used to spread the information, that all necessary precautions might be taken. Since the barometer was falling rapidly a special observation was taken at 10:20 a. m. and all particulars sent to the bureau. Wind was then blowing at 36 m. p. h. from NW, with very heavy sea swell. Rain falling. At 1 p. m. the velocity of the wind had increased to 100 m. p. h. NW., with a very heavy sea swell, the intensity of the storm gradually increasing. A special observation was sent to the bureau. At this hour the office was flooded and the sea breaking over the top, carrying all before it. Huge blocks of cement weighing a ton being washed around as if mere pebbles. At 1:55 the storm had reached such intensity as to indicate that everything would be demolished. Wind then about 150 m. p. h., unroofing the

office buildings, the roof of corrugated iron being carried about one mile inland. The sea swell at times was well above the window sills and before it could recede was caught by the next swell, the sea reaching inland for about three-quarters of a mile. The rain and sand at this time were blinding. The wind was so intense that the prickles from the prickly pear were blowing about like dust, being stripped off as the wind would strip a tree of its leaves.

At 5 p. m. it was deemed advisable to take shelter at the commissioner's residence. It took fully 40 minutes to cover a distance of less than a quarter of a mile; after a fierce fight we managed to reach our destination.

At 9:30 p. m., the storm having abated somewhat, the wind suddenly veered round to SE., still of a velocity of about 80 m. p. h.

The instruments of the bureau suffered badly. Cups of the anemometer were found half a mile away. The shelter with the thermometers was blowing around as if a sheet of paper. When eventually picked up it was